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Gallman revisited: blacksmithing and American manufacturing, 1850–1870

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Abstract In nineteenth-century America, blacksmiths were a fixture in every village, town, and city, producing a diverse range of products from axes to wheels and services from repairs to horse shoeing. In constructing his historical GNP accounts, Gallman opted to exclude these "jacks-of-all-trades" from the manufacturing sector, classifying them instead as part of the service sector. However, using establishment-level data for blacksmiths from the federal censuses of manufactures for 1850, 1860, and 1870, we re-examine that choice and show that blacksmiths were an important, if declining, source of manufactured goods. Moreover, as quintessential artisan shops, a close analysis of their structure and operation helps resolve several key puzzles regarding industrialization in the nineteenth century. As "jacks-of-all-trades," they were generally masters of none (except for their service activities). Moreover, the historical record reveals that several of those who managed to achieve mastery moved on to become specialized manufacturers of that specific product. Such specialized producers had higher productivity levels than those calling themselves blacksmiths producing the same goods, explaining changes in industry mix and the decline of the blacksmith in manufacturing.

Keywords Blacksmith · Industrialization · Economies of scale · Specialization · Labor productivity · Gallman

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"Under a spreading chestnut tree.
The village smithy stands;.
The smith, a mighty man is he,.
With large and sinewy hands;.
And the muscles of his brawny arms.
Are strong as iron bands".

-Henry Wadsworth Longfellow.

1 Introduction

This paper re-examines the role of the blacksmith in nineteenth-century US manufacturing using establishment-level data from the decennial censuses of manufacturing for 1850, 1860, and 1870, in order to resolve important questions raised decades ago by Robert Gallman and others regarding commodity production and services during that period (Gallman 1960; 1966, Gallman and Weiss 1969). It also provides important new evidence on the relationship between scale, specialization, and productivity in nineteenth-century manufacturing. While often overlooked by students of early industrialization, we argue that the blacksmith was a central character in the transition of manufacturing activity from small scale activity by generalists serving very local markets to more specialized and productive operations serving a dispersed clientele.

Blacksmiths produced a wide range of products and supplied important services to the nineteenth-century economy. In particular, they produced horseshoes and often acted as farriers, shoeing horses, mules, and oxen. This was a crucial service in an economy where these animals provided the most of the draft power on the farm and in transportation and carriage. The village blacksmith also produced a wide range of goods from agricultural implements to pots and pans, grilles, weapons, tools, and carriage wheels among many other items familiar and unfamiliar to a modern audience—a range of activities largely hidden behind their generic occupational title.

Blacksmithing was a sufficiently important activity to qualify as a separate industrial category in the nineteenth-century US manufacturing censuses, alongside more familiar industries as boots and shoes, flour milling, textiles, and clock making. The 1860 manufacturing census, for example, enumerated 7504 blacksmith shops employing 15,720 workers, producing an aggregate gross product of $11,641,213 (current dollars, see United States. Census Office. 1872, p. 399)—in terms of the number of establishments, the fourth most common activity behind lumber milling, flour milling, and shoemaking. Although the absolute number of blacksmith shops would continue to increase for some time after the Civil War, their number declined relative to manufacturing as a whole and, more importantly, relative to industries such as agricultural implements and carriage-making whose goods competed with those produced by traditional blacksmiths. By the early 1900s,

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blacksmiths were no longer listed as a separate industry in the Census of Manufactures.[1]

This paper uses the Atack and Bateman (1999) plant-level samples from the surviving manuscript schedules of the census of manufacturing for 1850, 1860, and 1870 to study three aspects of historical blacksmithing.[2] The first concerns the distribution of the gross output of blacksmiths between manufactured goods and services such as repair work and horse shoeing. This exercise, using enumerated but un-tabulated census information on inputs and outputs, raises questions regarding decisions made by Gallman (1960) to exclude "hand trades," including blacksmithing, from his estimates of manufacturing value added over the period 1839–1899. Second, we study the relationship between the product mix, shop size, and labor productivity among blacksmiths. We show that the correlation between the manufactures share and establishment size, as measured by the number of workers, was positive—or, to put it another way, the smallest blacksmith shops had a product mix that favored services like repairs and horse shoeing. Third, we use the product codes to study the differences in gross output per worker between those blacksmith shops that produced, for example, plows versus those establishments that also produced plows but reported their industry to be "agricultural implements" rather than blacksmithing. We find that, holding the type of good produced constant, the self-identified *specialized* producer of the good—agricultural implements, for example—had higher productivity, on average, than blacksmiths making ostensibly the same product.

2 Blacksmithing and nineteenth-century manufacturing: background

The village blacksmith was a common sight in early nineteenth-century American communities, along with cobblers, shoemakers, grist mill operators, and other artisans. Blacksmiths made goods from wrought iron or steel. This metal was heated in a forge until pliant enough to be worked with hand tools, such as a hammer, chisel, and an anvil. Others also worked with metal but what distinguished blacksmiths was their abilities to fashion a wide range of products from start to finish and even change the properties of the metal by activities such as tempering, as well as repair broken objects. Over time, blacksmithing went into decline, displaced by manufacturing establishments that specialized in individual products once produced by blacksmiths.

[1] The 1900 census combined blacksmithing with wheelwrighting.

[2] Collection of sample data from the extant manuscripts of the nineteenth century censuses of manufacturing was begun by Bateman and Weiss (see 1981) and completed by Atack and Bateman. The Atack and Bateman samples pertain to the 1850 through 1880 census years, but we do not use the 1880 sample. This is because, as explained in the text, we rely heavily on information that the Census collected on the specific products that blacksmith shops produced—information which was not collected by the 1880 census. The basic sample data are available for download from https://my.vanderbilt.edu/jeremyatack/data-downloads/. This paper also uses additional information on business organization (e.g., partnership, corporation) culled from the original Atack–Bateman data worksheets; see Atack (2014).

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Given what blacksmiths did with their hands for a living, one might think that blacksmithing was a natural activity to categorize as "manufacturing." Indeed, as noted in Sect. 1, all of the nineteenth-century manufacturing censuses listed blacksmithing as a separate industry. Later on, however, economic historians have had other ideas.

In particular, in two celebrated articles Gallman (1960, 1966) provided the first credible estimates of GNP and its structure for the nineteenth-century USA. In the first article, Gallman (1960) presented series of value added, employment, and labor productivity in the "commodity-producing" sectors, namely agriculture, mining and manufacturing, and construction. The time series covered the period from 1839 to 1899, with benchmark estimates at 5-year intervals (e.g., 1854, 1859).[3] In the course of fashioning these estimates, Gallman made various adjustments to the published census data, one of which was to exclude industries that the Census had deemed to be "manufacturing" but which he did not. These excluded industries eventually would appear elsewhere in his national accounts, just not in manufacturing. For example, the Census considered carpentry to be a manufacturing activity, but Gallman disagreed, and re-classified it as construction. The point of departure for this paper was Gallman's (1960, p. 58) decision to exclude the so-called independent hand trades from manufacturing, of which there were six.[4], By far the most important quantitatively of these was blacksmithing.

To the extent that Gallman (1960) justified his exclusion restriction, the logic seems to have been that blacksmiths and the other hand trades were (mostly) employed in "independent shops" rather than the factories that already made up the bulk of employment in manufacturing in 1850 and which would grow to overwhelming importance by the end of the century.[5] In his comment on Gallman's article, Potter (1960, p. 67), however, pointed out that the hand trades did, in fact, make physical products which were, in principle, part of manufacturing and, hence, that Gallman's value-added estimates, by excluding these workers, were biased downwards. But in a nod to Gallman's logic, Potter also asserted that the hand trades "were in considerable part displaced by manufacturing during the period 1839–1899[.]" As a result, the downward bias was greater earlier (e.g., 1839) in the period than later (1899), and therefore, the growth rate of manufacturing, as estimated by Gallman, was biased upwards. As we discuss later in the paper, our analysis of the product codes in the Atack–Bateman samples supports Potter's conjecture, but also concludes that the upward bias in Gallman's estimates is very

[3] Gallman's (1960) appendix gives the details of his estimation procedure. In the case of manufacturing, the basic sources are the federal censuses, starting in 1840. These were supplemented by various state censuses, which were used to interpolate to mid-points (e.g. 1854) between federal census dates.

[4] The six are blacksmithing, locksmithing, coppersmithing, whitesmithing (tin), gunsmithing, and carriage-smithing; see Gallman (1960). As discussed in "Appendix 2" of this paper, not every hand trade was enumerated separately in every census.

[5] As we discuss later in the paper, an obvious problem with this logic is that median establishment size in manufacturing in 1850 was two workers and approximately 80% of establishments had five workers or fewer (Margo 2015, p. 221). Moreover, a clear majority of all establishments through 1880 (and beyond) were sole proprietorships and corporations were rare—even if their products were not (Atack 2014, Tables 17.1 and 17.2). We return to this point later in the paper.

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small (see Sect. 3 and "Appendix 2"). Nevertheless, blacksmiths were important in other ways to the evolution of nineteenth-century manufacturing, as we will show.

About a decade after his initial work appeared, matters were clarified when Gallman published a co-authored paper with Thomas Weiss on the service sector (Gallman and Weiss 1969). Accepting Potter's point, Gallman and Weiss (1969, p. 347) recognized that workers in the hand trades could be "employees of manufacturing establishments" or they could have been laboring "in small, independent shops." Workers in "independent" shops might be crafting goods, or they might be performing services, such as a blacksmith fixing a carriage wheel. Gallman and Weiss agreed that the former activity should be included in manufacturing, while the latter was clearly a service. The published census, however, did not divide the gross value of output in the hand trades into physical goods versus services making it impossible to determine how much of blacksmithing output consisted of manufactures—plows, for example—versus services, such as repairing broken tools or shoeing horses. Therefore, because Gallman had previously excluded the hand trades from commodity output, the only practical solution at the time was to put them in the service sector "so that their contribution does not go unrecorded" (Gallman and Weiss 1969, p. 347).

After the publication of the Gallman and Weiss article, the issue lays dormant for three decades until the appearance of the paper by Jeremy Atack and Fred Bateman announcing their samples from the surviving manuscripts of the nineteenth-century manufacturing censuses (Atack and Bateman 1999). In a brief discussion toward the end of the paper, Atack and Bateman (1999, p. 187) used census information on establishment outputs to point out that that blacksmiths "produced a wide range of goods that fully deserve to be called 'manufactured products'" such as "pots and pans … plows, fanning mills, hoes, scythes, knives, and wagons[.]" thereby agreeing with Potter (1960)). Moreover, they used the product descriptions in the census manuscripts (see below) to provide illustrative calculations of the (sometimes substantial) contribution of blacksmiths to goods production.

Since most blacksmith shops were small and remained small, the historical evolution of that industry may also be helpful in assessing the role of economies of scale in nineteenth-century manufacturing. There is now a long literature making use of establishment-level data from the manuscripts of the nineteenth-century manufacturing censuses to estimate the parameters of production functions econometrically, from which the extent of economies of scale can be calculated. Early work, for example, Atack (1976, 1977) or Sokoloff (1984) found evidence of economies scale, based on production function estimates, but a recent re-evaluation of this earlier literature by Margo (2015) suggests that the finding of scale economies is not robust.

The fundamental problem is that very small manufacturing establishments have higher labor productivity in value-added terms than large establishments (Sokoloff 1984). As we show later in the paper, this type of effect is clearly present among blacksmiths but, by using the product information collected by Census, we can make two points that have previously gone unremarked. First, we show that the very smallest blacksmith shops had very different product mixes from larger shops. This may be important for economies of scale estimation. Second, comparing output per

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worker exclusively producing specific products in blacksmith shops with that in establishments describing themselves as manufacturers of that particular product, we find that, ceteris paribus, labor productivity was lower in the blacksmith shops. Putting these two results together, we suggest that the small firm effect found in the census data may be due, in part, to selection bias.

In the case of blacksmiths, over the course of the nineteenth century, most of them either exited the industry (like John Deere), or those with the talent and strength to work metal ended up as employees ("mechanics") in factories that made iron and steel products. Those blacksmiths who remained in the "industry" either were engaged in high value services that required special skills—repairing a specific tool or product, for example—or else worked within remote isolated markets with limited "market access" to the specialized industries whose products were displacing blacksmithing elsewhere.

3 Data

Our empirical analysis makes use of the national samples of establishments collected by Atack and Bateman (1999) from the 1850–1870 federal censuses of manufacturing. Panel A of Table 1 shows statistics on blacksmiths derived from the published 1850–1870 censuses of manufacturing. Blacksmith shops were 8% of manufacturing establishments in 1850, 5% in 1860, and nearly 10% in 1870. This zig-zag pattern in the time series led Gallman and Weiss (1969) to argue that blacksmiths were under-enumerated in 1850 and 1860 which, in turn, led them to make upward adjustments in their estimates of service sector output before the Civil War. Allegedly, the under-enumeration was concentrated in the left tail—the smallest blacksmith shops whose annual gross output was close to the census cutoff of $500. The census certainly claimed to make a better effort at enumerating small manufacturing establishments in 1870 (United States. Census Office 1872), which Gallman and Weiss argue accounts for the increase in the blacksmith share of total establishments between the 1860 and 1870 censuses. However, the census cutoff of $500 was never adjusted for changes in the price level and, because the Civil War inflation persisted into the late 1860s, we would expect that the blacksmith share would be higher in 1870, even if no changes in enumeration protocols had been made—which is to say the $500 cutoff was no longer the barrier that it once had been because of the Civil War inflation.

The analogous statistics from the Atack–Bateman national samples are shown in Panel B for those observations meeting the standard sample screens that we use in our previous work (see, for example, Atack, Bateman, and Margo 2008).[6] Since the samples provide establishment-level data, we can also determine the impact of imposing a real, as opposed to nominal, $500 cutoff. This drives the share of

[6] Specifically, we drop observations for which no labor, or capital, or inputs, or outputs were reported, if value-added (output value minus input value) was negative, if the business produced less than $500 worth of (nominal) annual output (such establishments were not supposed to be included in the census) and those whose estimated rate of return lay in the upper or lower 1% (on the grounds that these were outliers and must have suspect data).

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Table 1 Blacksmiths in American manufacturing, 1850–1870

Year	Number of blacksmith shops	Blacksmith percent of: total establishments	% Gross value of output	% Employment	% Capital	% Raw materials	% Value added
(A) Published census[a]							
1850	10,373	8.5%	1.0	2.6	1.1	0.9	1.1
1860	7504	5.3	0.6	1.2	0.5	0.3	1.0
1870	26,364	10.5	1.0	2.6	0.8	0.5	1.6
(B) Atack–Bateman national samples: with sample screens[b]							
1850	430	8.7%	1.5%	2.6%	1.0%	0.9%	2.1%
1860	339 [336]	6.8 [6.7]	1.1 [1.1]	2.0 [2.0]	1.0 [1.0]	0.7 [0.7]	1.8 [1.7]
1870	346 [290]	9.0 [8.0]	0.7 [0.6]	1.6 [1.4]	0.5 [0.5]	0.4 [0.4]	1.1 [1.1]

(C) Distribution of establishments by reported employment: blacksmith shops, Atack–Bateman national samples with sample screens[c]

	1–2 workers	3–5	6–15	16 or more
1850	67.5%	28.8%	3.5%	0.2%
Blacksmiths	45.6	28.4	16.5	9.5
All				
1860	77.1	18.2	3.9	0.8
Blacksmiths	45.6	27.4	16.8	10.3
All				
1870	77.2	21.0	1.7	0
Blacksmiths	37.2	28.9	19.5	14.4
All				

[a] *Source*: United States. Census Office. 1872, pp. 394, 399 and 406

[b] *Source*: Atack et al. (2004). Establishments must be in the national samples to be included in the table. One blacksmith observation in the 1850 national sample is dropped as an outlier. All establishments have positive values of reported employment, capital, inputs, and value added, and $500 in gross output measured in current dollars; in addition, establishments with very high or low estimated rates of return are dropped. []: to be included observations must have $500 of real gross output, measured in 1850 dollars; 1860 cutoff is $518; 1870 cutoff, $826

[c] *Source*: see Panel B. Sample screens are the same as in Panel B

blacksmiths in 1870 below the level observed in 1850, consistent with the long-run (1850–1900) trend, but there is still a rise in their share between 1860 and 1870. The rise between 1860 and 1870, however, was concentrated in the South, where it may reflect a temporary response to the various economic dislocations associated with the Civil War (Atack and Bateman 1999) that forced a return to more local self-sufficiency.

Although blacksmith shops made up a non-trivial share of all manufacturing establishments, they constituted a much smaller share of gross value, factor use (employment, capital, and raw materials), and value added than their number would

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suggest. For example, in 1850, when blacksmith shops made up a little more than 8% of establishments reported in published census, their share of employment was far smaller, just 2.6%. Indeed, regardless of how size is measured, blacksmith shops were, on average, small and their size distribution was heavily skewed to the left. As we show in Panel C, where we compare the distribution of establishments by the number of workers, this was true relative to the overall distribution—in each of the three census years. A far larger share of blacksmith shops had just 1 or 2 workers than in manufacturing as a whole.

Not only were blacksmith shops smaller than the norm in manufacturing, they were also less productive in revenue terms. This is apparent in both Panels A and B, by comparing the blacksmith share of total value added, which is always less than the blacksmith share of employment, implying that output per worker was lower, on average, in blacksmith shops than the average in manufacturing.

Panel C illustrates a basic conceptual problem with Gallman's (1960) original decision to exclude the "independent" hand trades from manufacturing. If true "manufacturing" only took place in larger establishments as opposed to "independent shops"—defined as a sole proprietor, or a proprietor plus perhaps an assistant—then the vast majority of establishments should have been dropped, even in industries such as flour milling where there is no question whether the work force was providing a service or making a product for sale. However, the published census volumes for the earlier years in Gallman's analysis never included size distributions of establishments, so there was simply no way for him to exclude "independent" shops, except wholesale by industry (such as blacksmiths). But, as Panel C shows, size alone cannot be the criterion for exclusion.

On the census forms that the enumerators submitted to Washington DC, they reported the name of each manufacturing establishment that they visited. This information was not encoded in the original Atack–Bateman samples primarily because of technological constraints when the earliest data were collected.[7] It was, however, recorded on the original worksheets (in the authors' possession) and contains useful and useable information. These "doing business as" names for each sample establishment have since been examined and categorized, although the names themselves are still not attached to each sample observation.[8] They were categorized as follows: an establishment doing business as, say, "John Smith" was deemed a sole proprietorship while "John Smith and Son(s)" or "John Smith and George Smith" was categorized as a family business. We classified businesses with names like "John Smith and Johan Schmidt" as partnerships, distinguishing between those businesses with just two individual's names and those with more than two. Businesses whose name was impersonal or included the word "mill," "factory" (or similar), or "corporation" (or "Co.") were classified as incorporated, for example "The Ohio Iron Co." Virtually all such businesses were large. More

[7] Specifically, space was at a premium since the data had to be transferred to 80-column Hollerith punch cards after encoding for entry into the mainframe computer. Moreover, the primary scientific programming language of the time (FORTRAN) was not well suited to string manipulation.

[8] A few individual worksheets are missing from their worksheet folders—presumably these were removed at some point over the past fifty years or so to check information and not returned (or improperly filed). In these cases, the "doing business as" field has been coded as missing.

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Table 2 Business organization and average employment of all manufacturing businesses and blacksmithing establishments

	Sole proprietorships	Blacksmiths organized as sole proprietorships	Familial	Partnership	Silent partnership	Corporation
(A) Share of establishments:						
1850	82.6	91.6	3.6	7.8	4.3	1.7
1860	76.8	90.3	4.3	9.2	7.0	2.7
1870	73.0	89.6	4.9	10.7	7.5	3.9
(B) Average employment in:						
1850	6.0	2.3	10.4	9.3	25.0	69.3
1860	6.0	2.2	17.1	12.7	23.3	50.1
1870	7.4	2.0	16.6	12.9	23.4	79.5

Source: (Atack et al. 2004) augmented by worksheet data

challenging were those businesses whose name included "& Co(mpany)" (note the ampersand). These were classified separately and are believed to represent partnerships with one or more "silent" partners. Most state laws provided that such individuals were not jointly or separately liable for the debts of the business beyond their initial investment provided that they remained silent on the day-to-day management of the business (Bates 1886; Burdick 1899; Hilt and O'Banion 2009; Howard 1934).

Dividing the establishments in the samples into these various organizational forms suggests that over 82% of all manufacturing establishments were organized as sole proprietorships in 1850, declining to 77% in 1860 and 73% in 1870 (Table 2, Panel A).[9] These businesses engaged an average of about 6 workers (Table 2, Panel B). Businesses that we believe were incorporated, however, made up only 1.7% of all manufacturing establishments in 1850, growing to just 3.9% by 1870, but they generally had ten times as many employees per establishment as the sole proprietorships.

If we restrict the sample to just those businesses identifying themselves as blacksmiths, sole proprietorships made up about 90% of the business population in that industry and these establishments had, on average, just two workers—likely the blacksmith and a helper (to work the forge bellows, hold the metal punch, or clip the softened iron, and so on). Moreover, the bulk of the remaining population of blacksmiths were organized either as family concerns or partnerships and differed little in size one from the other.

In collecting the manufacturing data, the census enumerators also quizzed respondents regarding the types of products that each establishment produced, as well as their quantity (if relevant) and value. This information was also never tabulated by the Census, but most of it was encoded in the Atack–Bateman manufacturing samples and is central to our analysis.[10] The

9FL01 [9] These figures differ slightly from those reported in Atack (2014) because of the application of data
9FL02 screens here to eliminate observations with any missing or suspect data.

10FL01 [10] See http://my.vanderbilt.edu/jeremyatack/files/2011/08/MFGDOC.pdf.

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instructions to enumerators called for each establishment to be asked to list by name up to five products or services provided by the establishment and up to six physical inputs used to produce those outputs. Each was listed in order of importance, and along with the name of the product or raw material, information was also collected on quantity (and the units of measurement) and their value.[11] These inputs and outputs were converted to numeric codes for type and units and are identified in the codebook to the Atack and Bateman samples. When data collection was complete, the samples used a total of 1395 separate product codes and 1295 raw materials codes.[12] From census year to census year, these codes grew more numerous and specific, suggesting that manufacturers were increasingly particular and specific in describing the products that they used and made—for example, anthracite coal rather than just "coal" and "rakes" and "plows" rather than just "agricultural implements." We make extensive use of these final product codes in our analysis of blacksmithing activities that follows.

4 The mix of services and manufacturing among blacksmiths

There were 83 separate final product codes used for blacksmiths (see "Appendix 1"), covering a wide range of products and activities. We have collapsed these into a set of six broad product categories—general blacksmithing (such as jobbing and including horse shoeing); hardware (harness fittings, nails, hinges, latches, and the like); implements (such as hoes, plows, rakes, and tools); iron work (like fencing and generic "iron work"); repair services; and carriages, wagons, and wheels. Many blacksmith shops still produced more than one of these broadly defined products.

Panel A of Table 3 shows the fraction of the gross value of the primary activity (the first product listed in the census enumerations per instructions) as distributed across the product category, along with the distribution of establishments. A solid majority—two-thirds, for example, in 1850—of total blacksmith gross value (and, for that matter, of blacksmith shops themselves) were engaged in what we call "general blacksmithing" or repair services. Moreover, by 1870, the share of

[11] As previously noted, not all of this information made it into the original Atack–Bateman samples since the data were encoded on 80-column Hollerith punch cards—three cards per observation, one for labor, capital, power, location, etc., one for inputs, and one for outputs. Bateman and Weiss determined that no more than four inputs and output values, quantities and codes could be accommodated within the 80-column space of a single card. However, since few establishments reported more than four inputs or outputs, they opted to consolidate the additional data from those few observations rather than add more (mostly blank) input and output cards per observation. When there were more than four distinct inputs or outputs listed, the values of the least important raw material inputs and outputs were aggregated and coded as "miscellaneous" as the fourth input or output. A similar practice must also have been adopted by the enumerators as they sometimes listed a "miscellaneous" category as the last input or output in their enumeration.

[12] In the public code book accompanying the Atack–Bateman sample (http://my.vanderbilt.edu/jeremyatack/files/2011/08/MFGDOC.pdf), a few products have multiple codes that survived the data cleaning process so that the number of different products or raw materials is slightly less than reported in the text. The multiple codes are allowed for in assigning broad product categories.

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Table 3 The product mix in blacksmith shops

	General blacksmithing	Hardware	Implements	Iron work	Repair services	Carriages, wagons, and wheels	Number of observations
(A) Distribution of primary product code by product category: blacksmith shops, 1850–1870[a]							
1850	63.1%	11.9%	11.5%	1.7%	2.9%	9.0%	
	[63.3]	[2.3]	[16.9]	[1.8]	[2.3]	[13.5]	444 {84.2%}
1860	66.2	2.4	11.8	0	4.2	14.5	333 {54.3}
	[66.2]	[1.8]	[13.2]	[0]	[3.0]	[25.5]	
1870	62.5	0	[5.1]	1.0	21.4	11.6	275 {74.4}
	[63.3]	[0]		[1.5]	[15.6]	[14.6]	

(B) Blacksmith value of gross output attributable to goods manufacturing: lower and upper bound estimates, 1850–1870[b]

Year	Lower	Upper
1850	28.9%	65.4%
1860	24.1	53.9
1870	15.4	30.1

(C) Regression estimates, probability that blacksmith shop has 1 or 2 workers[c]

Dependent variable	=1 if one or two workers	=1 if one or two workers
% Manufactures of gross value	−0.110	−0.099
	(0.039)	(0.043)
Year dummies	Yes	Yes
Urban status and state dummies	No	Yes
Adjusted R-2	0.014	0.047

[a] *Source*: computed from Atack et al. (2004) national samples, 1850–1870 manuscript censuses of manufacturing. To be included in the table, an establishment must be a blacksmith shop (SIC code 769) and also meet standard sample screens (see chapter 3). Columns 2–6, outside parentheses: fraction of gross value of output of primary product; []: fraction of blacksmith shops listing the good or service as primary product. {}: fraction of total gross value of output accounted for by primary product

[b] Based on classification of primary, secondary, etc., output. Lower bound assumes that if the output is "jobbing," "miscellaneous," or "blacksmithing" that the blacksmith produced no manufactured goods. Upper bound assumes that if the listed good is one of these three, the blacksmith produced manufactured goods in the same proportion of gross value of the other blacksmiths in the sample who identified specific products (e.g., plows) or services (e.g., repair). Horse shoeing is treated as a service in both columns

[c] *Source*: see text. Standard errors in parentheses. $N = 1052$ establishments

blacksmith gross value classified as general blacksmithing or repairs had increased to 85%, that is to say blacksmith shops became less specialized in specific product production and more service-oriented over time.

Our general blacksmithing category is an amalgam of various activities. Some of these were (mostly) quite specific services, such as shoeing horses, while others were vaguely worded, such as "jobbing," "custom work," or simply (but unrevealingly) "blacksmith." Because of this, we have constructed two estimates

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of the share of blacksmith gross value that can be attributed to manufacturing activity, a lower bound and (plausibly) an upper bound. The lower bound assumes that unless a specific good is mentioned, such as a plow or an axe, the blacksmith was engaged entirely in supplying services. The upper bound excludes from the calculation any product codes that are too vaguely worded to be plausibly and clearly allocated to either services or manufactures, such as "jobbing." [13] We believe that these represent very conservative interpretations of the data and in calculating these lower and upper bounds, we use all of the product codes listed in the samples, not just the first (and primary) one, as shown in Panel A.

These lower and upper bounds on the fraction of the gross value of blacksmith output that properly constituted manufacturing for the census years 1850–1870 are reported in Panel B. The ranges are fairly large—for example, in 1850, the lower bound estimate of the manufactures share is about 29%, whereas the upper bound is 65%—because many blacksmiths reported one of their activities as "blacksmith." However, both the lower bound and upper bounds are decreasing over time—robustly so, indicating that the blacksmith "industry" was shifting strongly away from the production of manufactured goods and toward services, consistent with Potter's (1960) conjecture. Moreover, the range is narrowing over time.

The sharp decline in the manufactures share implies that Potter's (1960) criticism of Gallman's (1960) decision to exclude the hand trades was conceptually correct. Gallman understated the size of the manufacturing sector in 1850, and because the hand trades were declining over time, he therefore overstates the growth of manufacturing value added and productivity (output per worker). However, as we show in "Appendix 2", the resulting bias in Gallman's estimates is very small and can safely be ignored.

We previously noted that blacksmith shops, while always small on average, were also becoming even smaller over time, counter to the general trend in manufacturing (see, for example, Table 2, Panel B). The fact that the shrinking in size was occurring when blacksmiths were shifting toward services suggest that the two features of behavior—size and product mix—could be related. Regression analysis suggests that this was the case. Panel C of Table 3 reports the coefficient of the manufactures share of value added (lower bound estimate) and the probability that a blacksmith shop had at most two workers. The coefficient is negative and statistically significant, regardless of whether we control for geographic location—urban status and state—which might also matter for the size distribution. Larger blacksmith shops, in other words, had a product mix more tilted toward goods production, while those shops that specialized in services were smaller. The next

[13] We refer to our upper bound as "plausible" in the text because we are assuming, plausibly, that blacksmiths who reported their activities as, for example, "jobbing" were disproportionately engaged in services. Our upper bound excludes values associated with these activities from the calculation, causing the manufactures share to be higher than its true value. Exclusions occur within observations (for example, a blacksmith listing "jobbing" as one of its product codes will have the value of this excluded from its total gross value) or across observations (the shop will be dropped from the calculation if all of its gross value is associated with product codes that cannot be clearly assigned to either manufacturing or services).

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section explores how size and product mix affected labor productivity in blacksmithing.

5 Labor productivity in blacksmithing: the small firm effect, product mix, and industry endogeneity

A defining feature of nineteenth-century industrialization in the USA was the growth of large-scale production. At the start of the century, the vast majority of manufacturing took place in artisan shops but, by century's end, output and factors of production had shifted toward factories (Atack 2014). The shifts toward large-scale production was driven by improvements in internal transportation and changes in technology that created incentives for division of labor, and by greater access to financial markets which provided the monetary grease so that firms could grow in size.

It is a truism that economic historians believe that the shift toward large-scale production contributed to the growth of labor productivity in manufacturing through the exploitation of economies of scale. But using the primary source of data on nineteenth-century American manufacturing—the censuses of manufacturing—to document the existence of and measure the extent of economies of scale has proven to be problematic. The basic problem is a "small firm effect" on productivity—the smallest establishments, measured in terms of workers, have higher labor productivity than larger establishments (Sokoloff 1984). Moreover, in the economy as a whole, labor productivity was higher in services than in manufacturing (Gallman and Weiss 1969; Weiss 1967). Is it possible that variations in the product mix of businesses—especially if these establishments also produced services—might explain some of the "small firm effect" on labor productivity in manufacturing?

Sokoloff attributed the small firm effect to an alleged under-reporting of entrepreneurial labor in small firms which he "fixed" in the 1850 data by adding one person to each establishment's workforce. With the fix in place, Sokoloff was able to demonstrate the existence of fairly sizeable economies of scale based upon production function estimates, even in non-mechanized establishments which he attributed to pure division of labor—the specialization by individual workers in a specific task or group of tasks. More recent analysis by Margo (2015), however, finds no evidentiary basis for Sokoloff's specific adjustment and concluded that Sokoloff's conclusions were not robust.

A small firm effect is clearly present among blacksmiths. Column 1 of Panel A of Table 4 reports the coefficients of a dummy variable equal to one if the number of workers was one or two (i.e., was a small firm) from a panel regression of the log of value added per worker. The regression also includes fixed effects for census year (1860 and 1870), urban status, and the state in which the establishment was located. The coefficient of the dummy variable is positive and highly significant. Thus, even among blacksmiths, where there were relatively few large-scale establishments, the smallest shops were still significantly more productive than larger shops.

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Table 4 Productivity analysis: blacksmiths, 1850–1870

(A) Regression: log of value added per worker: blacksmith shops, Atack–Bateman samples, 1850–1870[a]

Dependent variable	Log (value added per worker)	Log (value added per worker)	Log (value added per worker)
% Manufactures of gross value		−0.127	−0.132
		(0.047)	(0.048)
1 or 2 workers?	0.111	0.105	0.097
	(0.036)	(0.036)	(0.035)
Log K/L included?	No	No	Yes
Urban and state dummies included	Yes	Yes	Yes
Year dummies included	Yes	Yes	Yes
Adjusted R-2	0.295	0.300	0.365

(B) Regressions of Ln (gross value of output): blacksmith shops versus agricultural implements establishments[b]

Dependent variable	Ln (gross value of output, primary activity)	Ln (gross value of output, primary activity)	Ln (gross value of output, aggregate)	Ln (gross value of output, aggregate)
Blacksmith = 1	−0.589	−0.605	−0.120	−0.151 (0.083)
	(0.139)	(0.154)	(0.083)	
Urban status and state dummies?	No	Yes	Yes	Yes
% Manufactures of gross value included?	NA	NA	No	Yes
Adjusted R-square	0.758	0.767	0.915	0.916

NA not applicable

[a] *Source*: see text. $N = 1052$ establishments

[b] To be included in the regressions, an establishment must be either a blacksmith shop (SIC code 969) or agricultural implements establishment (SIC code 352) producing an identifiable agricultural implement(s) as the primary activity. Standard sample criteria also apply. All regressions include fixed effects for year, product code of primary activity, and the following continuous variables: ln (workers), ln (capital), ln (value of raw materials). Factor inputs (e.g., ln (capital)) are aggregate, not specific to primary activity. $N = 225$. Standard errors in parentheses

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The product code information in the samples, however, provides a fresh insight into what may be going on here. Specifically, we test whether the product mix between services and goods manufacturing may explain the small firm effect. In the aggregate nineteenth-century economy, we already know that output per worker was highest in services (Weiss 1967), and this differential may have carried over within industries. As we showed in the previous section, the smallest blacksmith shops had a product mix tilted toward services rather than toward good production.

We can explore if this was the case by adding the product mix to the regression specification.[14] The variable is measured such that larger values represent a higher share of manufactures in the total. As can be seen in column 2 of Panel A, the manufactures share is negatively related to output per worker, consistent with the hypothesis that establishments that emphasized services had higher measured productivity. Relative to larger establishments, the smallest blacksmith shops had a product mix that favored services; and that, other factors held constant, the higher the share of services in the product mix, the higher was output per worker. That said, controlling for the product mix explains only a small portion of the small firm effect. The "small firm" dummy is still positive and highly significant.[15] The last column of Table 4, Panel A adds the log of the capital–labor ratio to the regression. This further reduces the effect of the small firm dummy as well, but the coefficient remains positive and highly significant.

The product codes can also be used to compare the productivity of blacksmith shops with establishments in other industries that produced the same good. One of the most important examples involves agricultural implements. In the first half of

14FL01 [14] For this purpose, we use the lower bound measure because this is defined for all product codes—and
14FL02 therefore, all blacksmith shops, whereas, as previously noted, the upper bound measure excludes activities
14FL03 for which the product code is too vaguely worded ("blacksmithing") to assign to manufactures or
14FL04 services.

15FL01 [15] At the suggestion of a referee, we conducted a sensitivity analysis in which we narrowed the sample in
15FL02 Panel A, Table 4, to blacksmiths that reported producing a specific agricultural good, whether this was the
15FL03 first, second, third, or fourth product listed. This is a narrower test of the small firm effect because it
15FL04 substantially restricts the product mix by construction, unlike the regressions in Panel A of Table 4.
15FL05 There is only one good for which there are sufficient observations in the samples to estimate such a
15FL06 regression—plows. Specifically, we compute a variable, PLOWVAL, which is the sum of the total value
15FL07 of plows produced (first through fourth products listed), and restrict the sample to blacksmith shops for
15FL08 which PLOWVAL was positive (in any census year). There are 89 observations in this sample. The
15FL09 dependent variable is the log of the value of plows, and the critical independent variable is the small firm
15FL10 dummy (=1 if one or two; the regression also includes dummies for urban status, state, year, and linear
15FL11 terms in the log of the number of workers, the log of capital invested, and the log of the value of raw
15FL12 materials. The coefficient of the small firm dummy is positive ($\beta = 0.147$) which, consistent with the
15FL13 argument in the text, could be attributed to selection bias; however, the standard error is large
15FL14 (s.e. = 0.476), so the coefficient is (very) imprecisely estimated, and we cannot reject the hypothesis that
15FL15 it is statistically zero. We also conducted a similar exercise focusing on blacksmith shops that derived at
15FL16 least 50% of their gross revenue from the production of wagons; in this regression, the dependent variable
15FL17 is log of value added per worker, and the regression includes the small firm dummy, urban status, state,
15FL18 and linear terms in the log of the capital–labor ratio and the share of gross value derived from wagons.
15FL19 There are 50 observations in this sample. The coefficient on the small firm dummy is positive, and the
15FL20 coefficient of the share of gross value from wagons is negative, again consistent with the patterns
15FL21 observed in Panel A of Table 4; like the "plows" regression above, however, both coefficients have large
15FL22 standard errors, and we cannot reject the hypothesis that they are statistically zero.

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the nineteenth century, blacksmiths in rural areas everywhere made hoes, rakes, plows, and many other tools for use on farms. By the end of the century, however, the vast majority of this production took place in factories whose owners considered themselves to be in the "agricultural implements" industry. In the Atack–Bateman sample, such establishments are given the (modern) SIC code 352 (United States. Office of Management and Budget 1987).

To make this productivity comparison, we limit the sample to those blacksmith shops (SIC 769) whose primary activity was the production of a specific agricultural implement, such as plows, as well as agricultural implements establishments (SIC 352) who did the same. Thus, in effect, we are holding constant what the establishments in both industries considered to be their primary economic activity. We have two dependent variables, the log of the gross value of the primary product, and the log of the gross value of total output. Our interest is in the coefficient of a dummy variable which takes the value one if the observation was a blacksmith shop (SIC 769). All of the regressions include fixed effects for the census year and the product code of the primary activity, and continuous variables in factor inputs (see the notes to Panel B of Table 4).

In part, our choice of comparing blacksmiths producing agricultural implements with "pure" agricultural implements manufacturers was guided by sample size. But, we are also cognizant of the case of John Deere, who operated as an independent blacksmith until in the late 1830s when he invented a plow that proved remarkably useful to Midwestern pioneer farmers. He subsequently formed a partnership with Leonard Andrus in 1843 to build enough plows to meet robust demand for his product, effectively abandoning his "jack-of-all-trades" blacksmithing to specialize on producing his plows. That partnership was dissolved in 1848, and Deere moved his company to Moline, Illinois where it prospered and grew in size (Broehl 1984), eventually broadening its offerings of agricultural implements beyond the plow. [16]

Our narrative of change over time in agricultural implements production implies that the coefficient of the dummy variable for blacksmith shops should be negative—that is, blacksmith shops were less productive than establishments in the specialized industry. As can be seen in columns 1 and 2 of Table 4, the hypothesis is strongly borne out, whether or not we include fixed effects for urban status and state in the regression. We are calling this the "John Deere effect": holding the type of good produced constant, the self-identified *specialized* producer of the good—agricultural implements, in this instance—had higher productivity, on average, than blacksmiths making ostensibly the same product.

Although the regressions in columns 1 and 2 control for factor inputs, these controls are not specific to the goods in question. Thus, it may be that blacksmith shops that were specialized in agricultural implements production allocated less labor, capital, and raw materials to producing such implements, relative to other

16FL01 [16] There are other examples of well-known industrial firms that started as independent blacksmith shops,
16FL02 for example, Studebaker Brothers, which began as a blacksmith shop in the early 1850s, but soon
16FL03 specialized in wagons and carriages. The company grew dramatically during the Civil War as a
16FL04 consequence of military contracts with the Union Army (Erskine 1918), a couple of decades after Deere
16FL05 made the same kind of transition to specialist product producer.

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activities. In columns 3 and 4, the dependent variable is the total value of gross output; the difference between the columns is that the regression in column 4 includes our estimate of the overall share of manufactures, while column 3 does not. The coefficient of the dummy variable for blacksmith shops is negative in column 3, but not statistically significant. However, once we control for the manufactures good share, the blacksmith shop coefficient is negative, larger in magnitude, and significant at the 5% level.

We believe that these results for blacksmiths suggest a plausible hypothesis for why it has been so difficult for economic historians to generate robust estimates of economies of scale from the nineteenth-century census data. Consider the goods produced historically by blacksmiths, such as plows. Over time, blacksmiths produced fewer and fewer of these, concentrating instead on services like shoeing horses or repairs. But even controlling for this, only the most productive of blacksmiths (or else those whose market was protected from competition in some way) survived—a selection effect. On the goods side of the market, production shifted toward establishments that were sufficiently productive that they could specialize in a particular "industry," such as John Deere in the agricultural implements industry. As this industry grew, it drew in workers—some of whom in an earlier era might have opened their own blacksmith shops, but most of whom now worked on the factory floor, perhaps doing some of the same tasks by hand that blacksmiths had done earlier but otherwise performing entirely novel tasks, because production process was increasingly mechanized. On average, such workers in the specialized industry were more productive than the "jack-of-all-trades," the blacksmith, had been formerly. The village smithy could and did produce rakes and hoes, but the village smithy eventually and increasingly gave way to businesses like (John) Deere and Company who did it better.

6 Concluding remarks

During the first half of the nineteenth century, blacksmiths were ubiquitous in the USA, but by the end of the century they were no longer sufficiently numerous or important goods producers to qualify as a separate industry in the manufacturing census. Blacksmiths are interesting to study because they were "jacks-of-all-trades," capable of producing manufactured goods like pots and pans, hoes and rakes, from scratch at an affordable price and of adequate quality and functionality but also capable of repairing a broken tool or carriage wheel. They were "gateways" to more specialized (and highly skilled) activities. In a famous paper, Gallman (1960) treated blacksmiths as a precursor to modern manufacturing—proto-industry—and therefore excluded them and their output from his estimates of manufacturing value added. While even at the time this was recognized as incorrect because blacksmiths did produce manufactured goods, there was no way for Gallman to measure the importance of manufacturing in blacksmith activity.

This paper has used the product codes in the Atack et al. (2004) samples of the manuscript censuses of manufacturing to measure the share of manufactures in blacksmith gross output for the census years 1850–1870. We also explore the

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relationship of the product mix to labor productivity. Over time the product mix among blacksmiths shifted toward services and the typical blacksmith shop became smaller, counter to the general trend in establishment size in manufacturing as a whole. The product mix and size were also related in cross section—the smaller the blacksmith shop, the higher was the share of output devoted to services. The product mix also helps to explain some of the "small firm effect" present in nineteenth-century US manufacturing census data, the tendency for the smallest establishments to have the highest value added per worker. However, much of the small firm effect remains even after controlling for the product mix.

We also compare labor productivity of blacksmiths and in establishments in a related industry, agricultural implements, controlling for the specific type of implement that the establishment considered to be its primary output. We show that blacksmiths were less productive than workers on average in the specialized establishments, even when we control for the product mix. Taken together, these two results on productivity help explain why blacksmith production of manufactured goods was displaced over time, but also why some shops were able to survive.

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Appendix 1

As indicated in the text, enumerators of the censuses of manufactures in 1850, 1860, and 1870 were instructed to list up to six raw materials used in the production of up to four individually identified final products. Specifically, the instructions stipulated that:

> "Under the general heading, entitled "*Annual products*" is to be inserted the *quantity, kind*, and *value* of *each* produced during the whole year. It will require great care to fill this column properly. When several articles are manufactured, the first four only need be particularly specified, and the remainder classed under a general heading of "Other articles," and the aggregate value of such articles carried out, the quantity being omitted; or, where otherwise impracticable in any case, the aggregate value, without the specific quantity or kind. In stating the value of the products, the value of the articles *at the place of manufacture* is to be given, exclusive of the cost of transportation to any market." [emphasis in original] (Wright 1900, p. 314)

The Bateman–Weiss coding scheme kept the spirit of these instructions within the space constraints imposed by an 80-column Hollerith punch card. To achieve this, they reduced the number of individually identified raw materials and final products to a maximum of the four most important (by value). In those cases where *more than four* inputs or outputs were identified, only the three most important by value were identified by specific codes and the value of the remaining inputs or outputs was aggregated, reporting that value under a code for "Miscellaneous."

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Collectively, the products made by the blacksmiths in the individual Bateman–Weiss state samples were classified under 83 different final product codes, 82 of which were unique (in the sense of different descriptions or units of measurement—including none). The duplicate code is for "miscellaneous."[17] In analyzing the activities of blacksmiths, we grouped these 83 final products (disregarding the units of measurement) into six broad groups (some of which represent judgment calls about what was meant by the product description).[18] Specifically:

"General blacksmithing work": blacksmithing, custom work, horseshoes, jobbing, joiner work (presumably welding, etc.), miscellaneous (horse) shoeing/shoeing, etc.,/shoes, and stove fitting.

"Hardware": copper, harnesses (presumably fittings thereof like bits, buckles, hame clips, and rosettes), hinges, iron cast, ironware, locks, locks, etc., millwork, nails, screws, shipwrighting (presumably fittings like oarlocks), spikes, springs, tableware, tinware, and wagon irons.

"Implements": agricultural implements, axes, corn planters, cradles, cultivators, edge tools, etc., farm/plantation, hoes, machinery, mining, planers, plows, reapers, scythes, steel work, threshing machines, tools, and wheat drills.

"Iron work": iron railings/rails, iron/ironwork, and wrought iron.

"Repairs": guns/rifles (almost certainly confined to repairing items such as trigger guard, sight, etc.), repair work, and wagon work.

"Wagons and Carriages": buggies, carriages, carts, coaches, wheel hubs, sleighs, wagons, wheels.

Appendix 2

We use our estimates of the share of blacksmiths' gross value added represented by their manufacturing (as opposed to services) output to explore the bias in Gallman's estimates of nominal value added in manufacturing for the census years 1850–1870.

17FL01 [17] Almost fifty years has passed since collection of these data began and it has been about 45 years since
17FL02 Atack did any product coding on them. No one remembers what the distinction was between the two
17FL03 "miscellaneous" codes, but they were assigned consecutively and very early in the project: 45 and 46.
17FL04 Initially, sequential numerical codes were assigned, began with "1." After the 99th code had been
17FL05 assigned, subsequent codes were alphanumeric beginning with A0 (A-zero) through A9, then B0 through
17FL06 B9, etc., as the coding sheets and punch cards allowed for only two characters for each code. Once the
17FL07 80-column Hollerith punch card constraint vanished (in the late 1970s with the switchover to terminals
17FL08 and eventually personal computers), all codes were translated into 4-digit numerical codes as entering
17FL09 only numerical data was faster, more accurate, and more consistent than a mix of numbers and characters.
17FL10 Atack's best guess for the initial distinction between the two "miscellaneous" codes is that "45" was
17FL11 used where the census enumerator had classified the product as "Other articles" (aka, miscellaneous)
17FL12 while "46" was used where Bateman and Weiss (and their student helpers) had done the aggregation, but
17FL13 this distinction was lost at some point. Certainly, Atack only remembers using "46" for "miscellaneous"
17FL14 (or not specified).

18FL01 [18] The following final product codes were used for establishments describing themselves as blacksmiths
18FL02 (SIC 769): 1, 7, 10, 11, 13, 16, 27, 28, 29, 32, 45, 46, 47, 52, 53, 54, 55, 57, 63, 64, 68, 74, 83, 94, 96, 124,
18FL03 130, 152, 164, 165, 168, 191, 192, 199, 203, 228, 257, 310, 346, 350, 351, 358, 366, 367, 370, 422, 446,
18FL04 519, 533, 537, 564, 611, 628, 629, 630, 640, 649, 650, 651, 655, 703, 789, 822, 829, 852, 854, 935, 982,
18FL05 985, 991, 1040, 1079, 1105, 1109, 1148, 1161, 1215, 1233, 1246, 1265, 1292, 1297, and 1308.

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Table 5 Gallman's estimates of aggregate value added in manufacturing, 1850–1870: the bias from excluding manufacturing output in the hand trades

Year	Gallman, value added in manufacturing	Hand trades, census value added	Ratio, hand trades/ Gallman (%)	Atack–Margo, adjusted estimates, manufactures value added, hand trades	Ratio, Atack–Margo/ Gallman (%)
1850	$447,000,000	$11,182,130	2.50%	$7,313,113	1.64%
1860	815,000,000	9,017,689	1.11	4,860,534	0.60
1870	1,631,000,000	31,283,699	1.92	9,416,393	0.58

Source: Gallman, value added: from Gallman (1960, Table A-1). Hand trades, census value added: 1850, sum of "value of product" less "cost of raw material" for "Blacksmiths" (p. 406) and "White and locksmiths" (p. 408); 1860, same, for "Blacksmiths" (p. 399), "Carriage-smithing" (p. 400), "Coppersmithing" (p. 400), "Locksmithing and bell-hanging" (p. 402), and "Whitesmithing" (p. 405); 1870, same, for "Blacksmithing" (p. 394), "Coppersmithing" (p. 394), "Gunsmithing" (p. 395), and "Locksmithing and bellhanging" (p. 396). Atack–Margo: column 3 multiplied by upper bound share of manufactures in gross value of blacksmithing, from Panel B of Table 3.

Gallman's estimates of nominal value-added (in hundreds of millions of current dollars) can be found in Table A-1 of his 1960 article (Gallman 1960, p. 43). In his discussion of the construction of the estimates, Gallman (1960, p. 57) notes that "[c]ensus manufacturing totals were adjusted to exclude nonmanufacturing industries … included in the census of manufactures of [1850] through [1870]."[19] Among these were six industries that Gallman (p. 58) collectively referred to as the "hand trades": blacksmithing and locksmithing (1850–1880), coppersmithing (1860–1880), whitesmithing (1850–1860), gunsmithing (1870–1880), and carriage-smithing (1860). For example, the 1860 census of manufactures includes a row pertaining to "carriage-smithing"; Gallman adjusts by excluding figures for this industry from his totals. The overwhelming majority of the totals for the hand trades pertain to blacksmithing.[20]

In column 2 of Table 5 we reproduce Gallman's estimates of nominal value added in manufacturing for 1850–1870. In column 3, we report total value added ("value of products" minus "value of raw materials") for the six hand trades; and, in column 4, the ratio of value added in the hand trades to Gallman's aggregates. Note that these ratios are absolutely small overall but smaller in 1870 than in 1850. This would indicate a modest upward bias in the aggregate growth rate of manufacturing value added in Gallman's estimates, if we were to assume that all of the value added in the hand trades pertained to manufacturing. We know that this is not the case for blacksmithing, but we lack data on the manufactures share for the other hand trades. However, this does not matter, because as noted above, blacksmithing accounted for the vast majority of economic activity in the hand trades. As a practical matter, therefore, we can adjust value added in the hand

19FL01 [19] For example, Gallman considered "carpentering" to be a nonmanufacturing industry, putting it into
19FL02 construction instead. It is important to keep in mind that none of the non-manufacturing totals were
19FL03 "lost"—they were simply put elsewhere in Gallman's national accounts. In the case of the hand trades,
19FL04 these went into services, as we pointed out in the text of our paper.

20FL01 [20] For example, in 1850, blacksmithing accounted for 97.8% of total value of products in the six hand
20FL02 trades.

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Table 6 Gallman's estimates of nominal output per worker in manufacturing: the bias from excluding manufacturing output and labor in the hand trades

Year	Gallman, gainful workers in manufacturing	Atack and Margo, estimates of L_M, hand trades	Ratio, Atack–Margo/ Gallman	Gallman, nominal value of output per worker in manufacturing	Atack–Margo, adjusted estimates, output per worker	Ratio, Atack–Margo/ Gallman, output per worker
1850	932,000	17,368	1.86%	$480	$479	0.998
1860	1,474,000	9454	0.64	553	553	1.000
1870	2,187,500	21,804	1.00	746	743	0.996

Source: Gallman, gainful workers: Gallman (1960, Table 6, p. 30). Gallman, nominal value of output per Worker: Column 2, Table 5 of "Appendix 1"/Column 2, Table 6 "Appendix 2"

trades downward by multiplying by the manufactures shares from Panel A of Table 3; for this purpose, we use the upper bound shares. In effect, we are assuming that, proportionately, manufacturing in the other hand trades was the same as in blacksmithing. These adjusted totals are shown in column 4, Table 5. The exclusion of manufacturing value added from the hand trades does bias upward Gallman's estimates of the size of the manufacturing sector, more at the beginning of the period (1850) than at the end (1870). While this supports Potter's (1960) conceptual criticism, the magnitude of the bias is trivial.[21]

We can also use our results to explore the size of the bias in Gallman's estimates of output per worker. To this end, we use the following equation, which pertains to the hand trades:

$$(V_M/L_M)/(V_S/L_S) = \beta$$

In this equation, V refers to value added, L to gainful workers, M to manufacturing, and S to services; β is the ratio of labor productivity in manufactures as opposed to services.[22] For the hand trades, we can estimate the V's from Table 5; we know the total $L = (L_M + L_S)$ from the census of manufactures; and we can estimate β from the regression in Panel A of Table 4, assuming a manufactures share of 1 (we use the regression coefficient of the manufactures share from last column in Panel A of Table 4: $\beta = \exp(-0.132) = 0.876$). By rearranging the equation, we can estimate the ratio L_M/L_S; and because we know the total L, we can recover estimates of L_M.

In Table 6, we report Gallman's estimates of gainful workers in manufacturing (column 2); our estimates of L_M in the hand trades (column 3); the ratio of our estimates of L_M in the hand trades to Gallman's estimates of gainful workers in manufacturing (column 4); Gallman's estimates of nominal value added per worker

21FL01 [21] The ratio figures in the last column of Table 5 are still too large because we are using the upper bound
21FL02 shares of gross value, rather than, say the average of the upper and lower bounds. Further, it is likely that
21FL03 the share of manufactures in value added in the hand trades is lower still, because manufacturing used
21FL04 more raw materials per dollar of gross value than services.

22FL01 [22] We recognize that the typical blacksmith spent part of his time making manufactures and part of his
22FL02 time performing services; in effect, we are assuming that if the blacksmith spent half of his time making
22FL03 manufactures, this is the equivalent of 0.5 of a gainful worker.

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(column 5); our adjusted estimates of output per worker, which include manufacturing output and estimated gainful workers (L_M) from the hand trades (column 6); and the ratio of our estimates of output per worker to Gallman's (column 7).[23] There is a slight upward bias to Gallman's estimates of labor productivity, more so in 1850 than in 1870—again, consistent with Potter (1960)—but the magnitude of the bias is trivial (and literally zero in 1860).

References

Atack J (1976) Estimation of economies of scale in Nineteenth Century United States manufacturing and the form of the production function. Ph.D, unpublished dissertation, Department of Economics, Indiana University, Bloomington

Atack Jeremy (1977) Returns to scale in Antebellum United States manufacturing. Explor Econ Hist 14(4):337–359

Atack J (2014) America: capitalism's promised land. In: Neal L, Williamson JG (eds) The Cambridge history of capitalism. Cambridge University Press, Cambridge, pp 533–573

Atack J, Bateman F (1999) Nineteenth Century American industrial development through the eyes of the census of manufactures: a new resource for historical research. Hist Methods 32(4):177–188

Atack J, Bateman F, Weiss Thomas J (2004) National samples from the census of manufacturing: 1850, 1860, and 1870 (ICPSR 4048). Inter-University Consortium for Political and Social Research, Ann Arbor

Atack J, Bateman F, Margo RA (2008) Steam power, establishment size, and labor productivity in Nineteenth Century American manufacturing. Explor Econ Hist 45(April):185–198

Bateman F, Weiss TJ (1981) A deplorable scarcity: the failure of industrialization in the slave economy. University of North Carolina Press, Chapel Hill

Bates C (1886) The law of limited partnership. In: Little, Brown, Boston http://galenet.galegroup.com/servlet/MOML?af=RN&ae=F101533948&srchtp=a&ste=14&locID=29002

Broehl WG (1984) John Deere's company: a history of Deere and Company and its times. Doubleday, New York

Burdick, FM (1899) The law of partnership including limited partnerships. In: The students' series. Little, Brown, Boston http://galenet.galegroup.com/servlet/MOML?af=RN&ae=F101544572&srchtp=a&ste=14&locID=29002

Erskine Albert Russel (1918) History of the Studebaker corporation. Poole Bros, Chicago

Gallman RE (1960) Commodity output, 1839–1899. In: The Conference on Research in Income and Wealth (ed) Trends in the American Economy in the Nineteenth Century, Columbia University Press for the NBER, New York, pp 13–72

Gallman RE (1966) Gross national product in the United States, 1834–1909. In: Brady DS (ed) Output, employment, and productivity in the United States After 1800, edited by conference on research in income and wealth. Columbia University Press, New York, pp 3–76

Gallman RE, Weiss TJ (1969) The service industries in the Nineteenth Century. In: Fuchs Victor R (ed) Production and productivity in the service industries. Columbia University Press for the NBER, New York, pp 287–381

Hilt E, O'Banion K (2009) The limited partnership in New York 1822–1858: partnerships without kinship. J Econ Hist No 69(3):615–645

Howard Stanley E (1934) The Limited Partnership in New Jersey. J Bus Univ Chic 7(4):296–317

Margo RA (2015) Economies of scale in Nineteenth Century American Manufacturing: a solution to the entrepreneurial labor input problem. In: Collins WJ, Margo RA (eds) Enterprising America: Businesses, Banks, and Credit Markets in Historical Perspective. University of Chicago Press, Chicago, pp 215–244

[23] Gallman's estimates of gainful workers and of value added per worker include mining as well as manufacturing (i.e., value added per gainful worker in manufacturing and mining).

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Potter N (1960) Comment. In: The Conference on research in income and wealth (ed) Trends in the American economy in the Nineteenth Century, Columbia University Press for the NBER, New York, pp 67–69

Sokoloff KL (1984) Was the transition from the artisanal shop to the nonmechanized factory associated with gains in efficiency? evidence from the U.S. manufacturing censuses of 1820 and 1850. Explor Econ Hist 21(4):351–382

United States. Census Office (1872) The statistics of the wealth and industry of the United States, embracing the tables of wealth, taxation, and public indebtedness; of agriculture: manufactures: mining: and the fisheries with which are reproduced, from the volume on population, the major tables of occupations. Compiled, from the original returns of the Ninth Census (June 1, 1870), under the direction of the Secretary of the Interior, by Francis A. Walker, Superintendent of Census. In: H.misdoc.46. Washington: [s.n.]. http://congressional.proquest.com/congcomp/getdoc?SERIALSET-ID=1475+H.misdoc.46

United States. Office of Management and Budget (1987) Standard industrial classification manual. For sale by National Technical Information Service, Springfield

Weiss TJ (1967) The service sector in the United States, 1839 through 1899. Ph D, University of North Carolina, Chapel Hill

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MS Code : CLIO-D-17-00023 | ☑ CP | ☑ DISK